

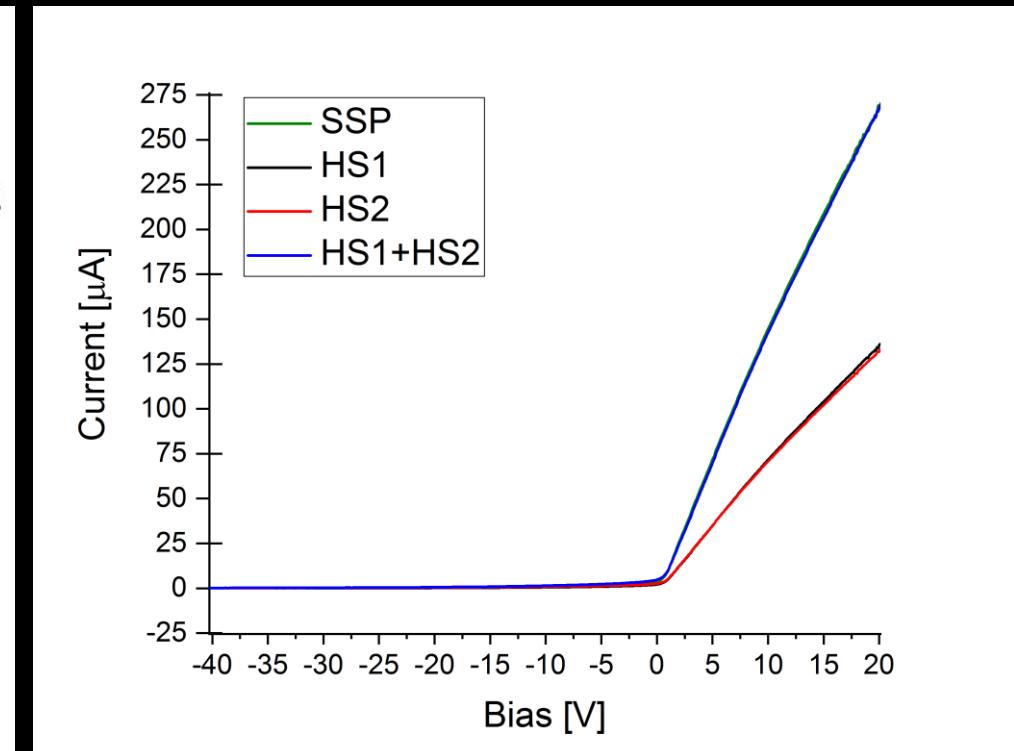
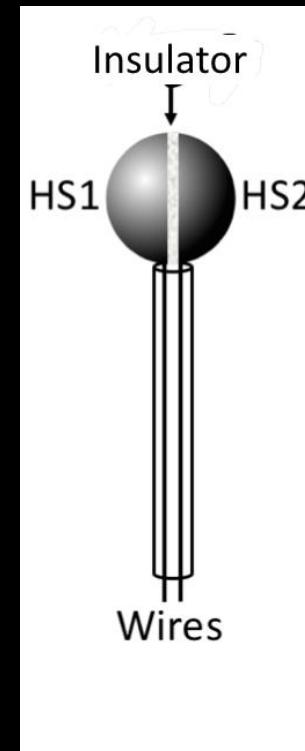
Retrieving True Plasma Characteristics from Langmuir Probes Immersed in the Spacecraft Sheath using a Double Hemispherical Probe

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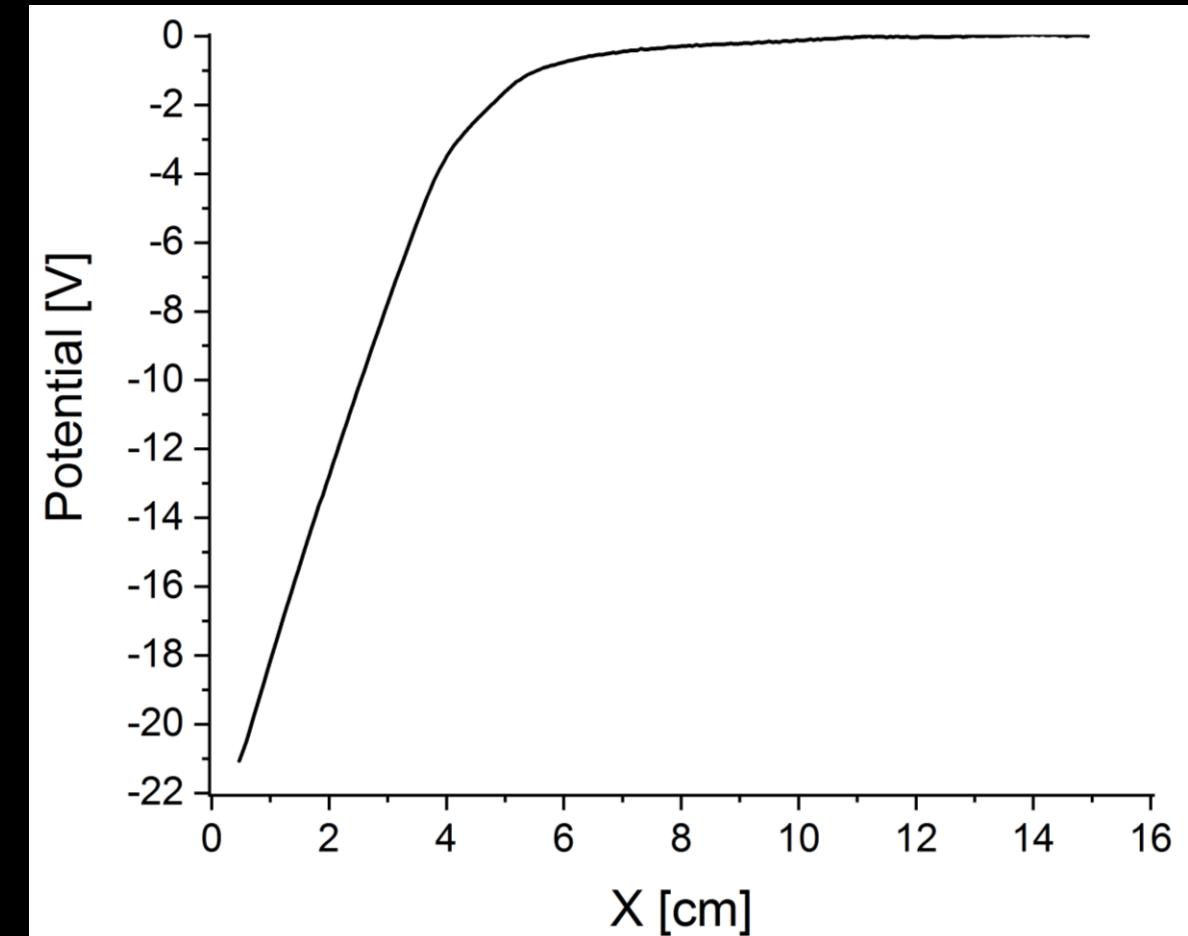
Langmuir Probes and the DHP

- Langmuir probes are conductors inserted into a plasma measure Plasma/Spacecraft (SC) potential, electron temperature, and electron density by analyzing the current-voltage (I-V) curves of the probes.
- The Double Hemispherical Langmuir Probe (DHP) is a spherical probe with isolated hemispheres that are swept together.



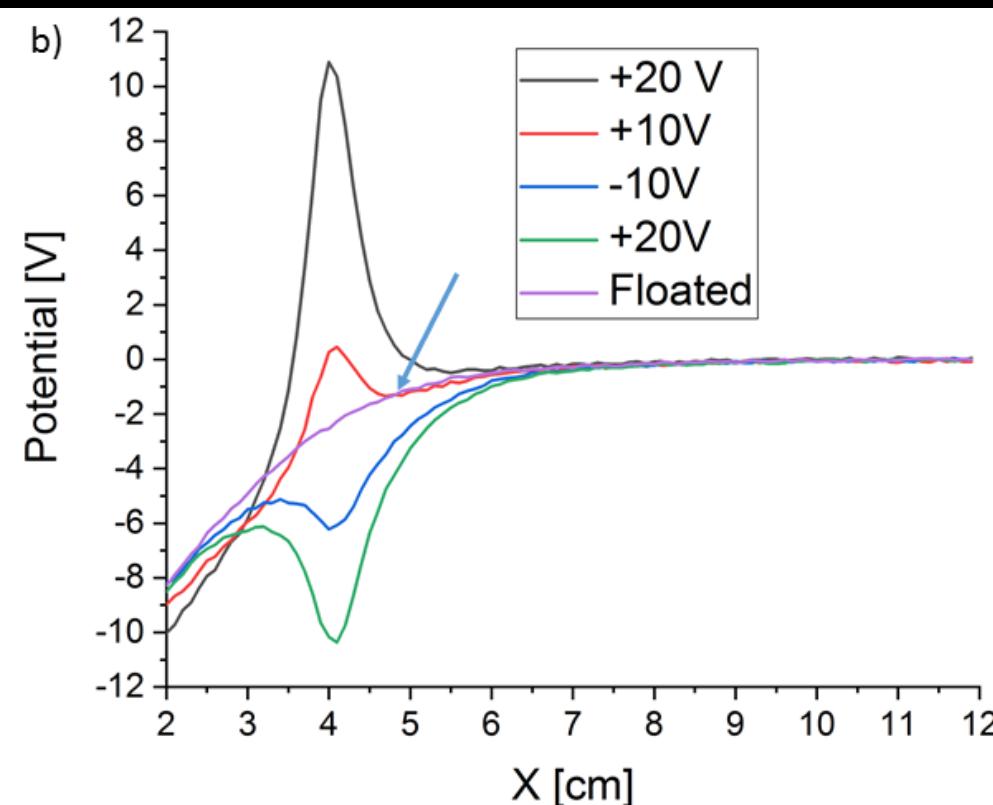
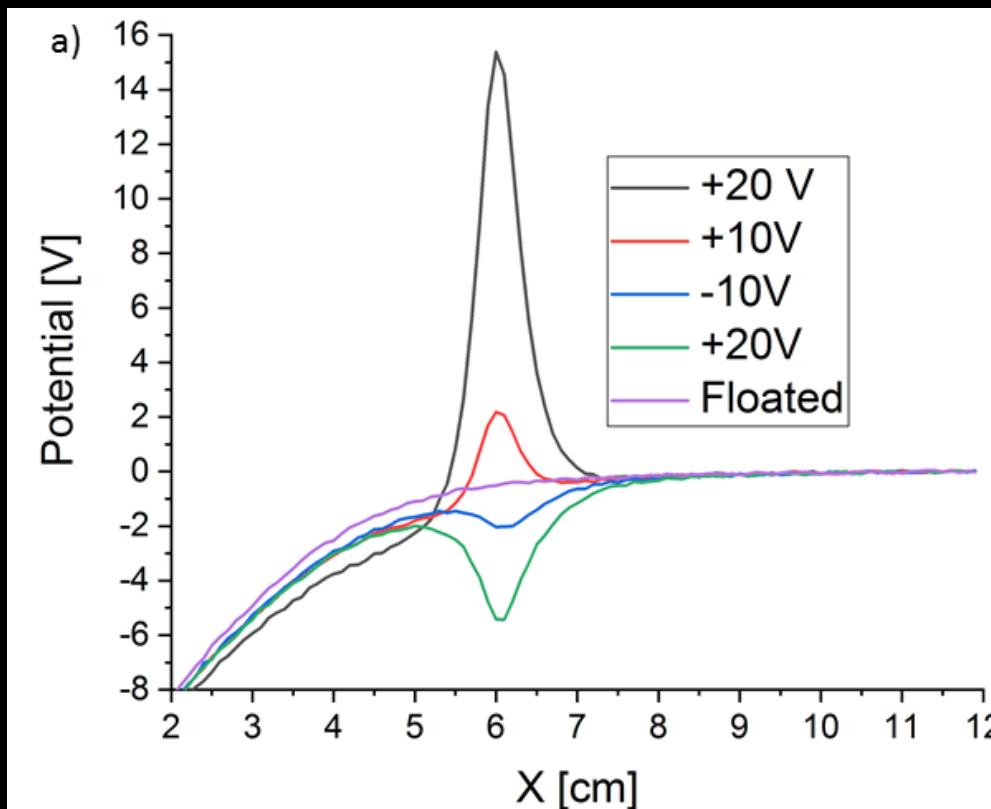
Spacecraft (SC) sheath

- Due to SC charging a region of non uniform plasma will be created around the SC, or any conductor, and is called a Debye sheath.
- The potential will vary as you get closer to the SC, effecting measurements of any probe inside it.

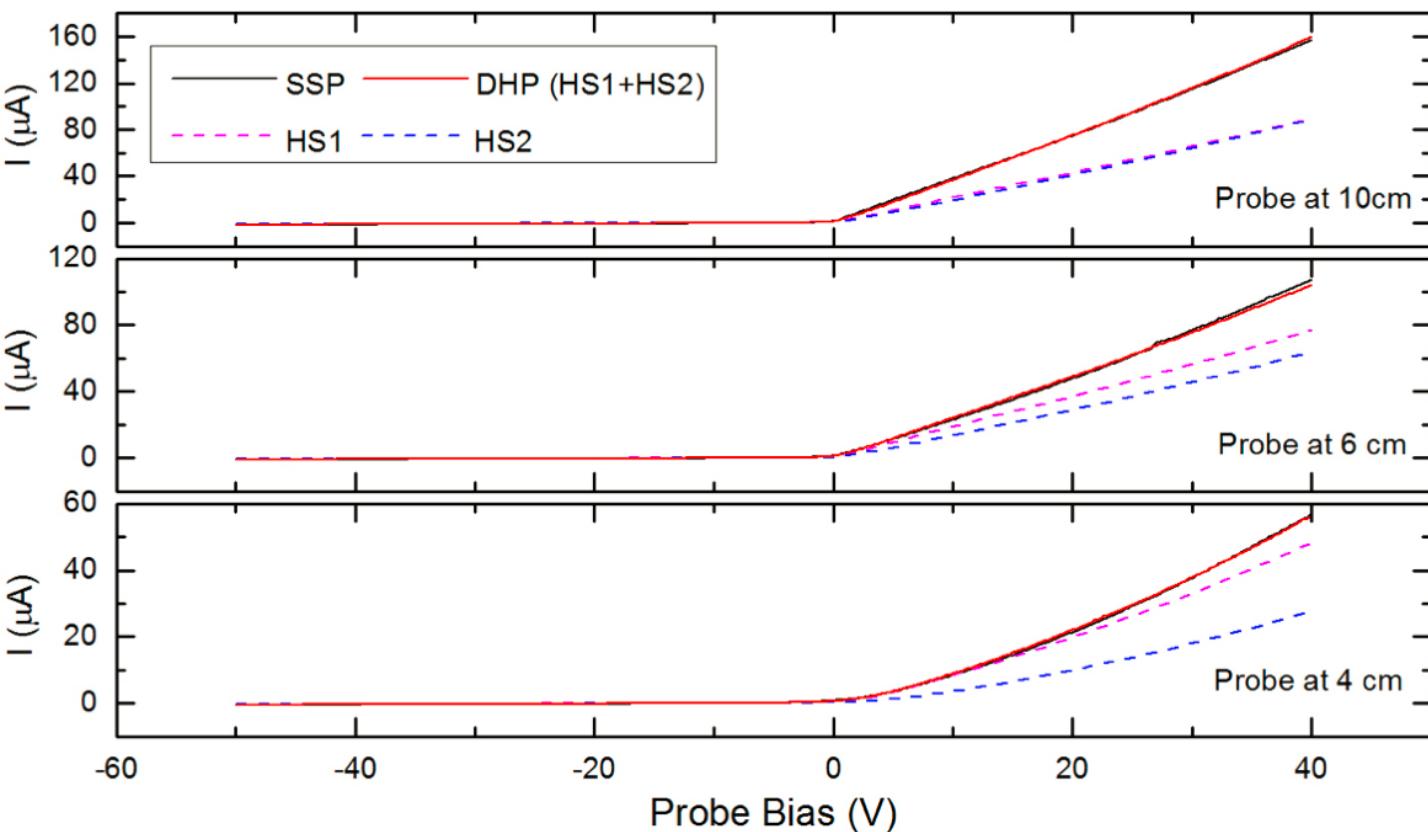
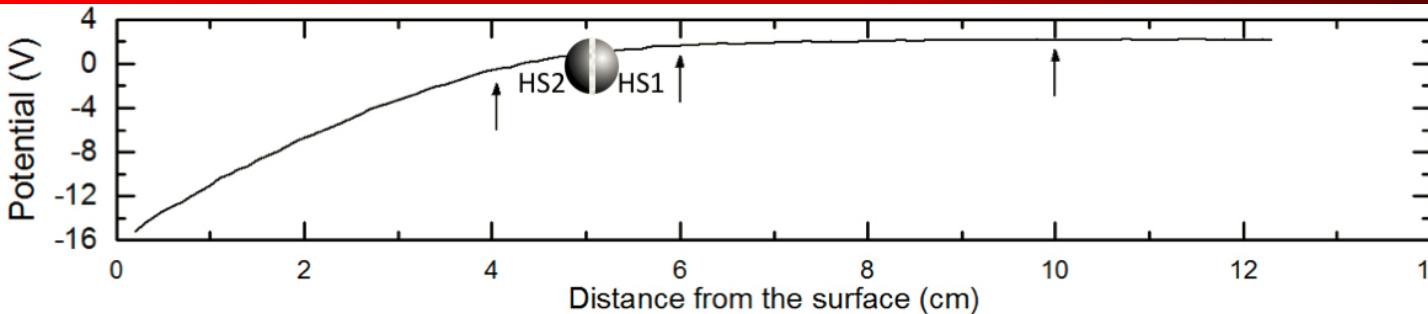


Probes in Sheath

- In the bulk each hemisphere is ‘sees’ the same potential.
- In the bulk not only is the potential ‘seen’ by either hemisphere asymmetric, but also nonmonotonic.



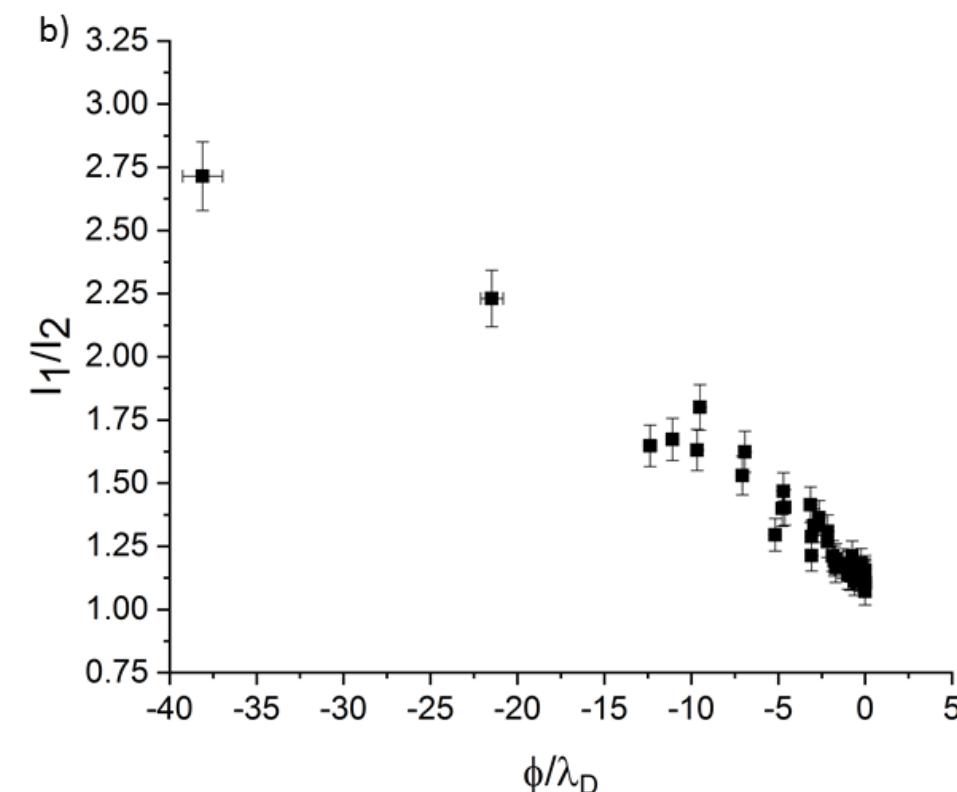
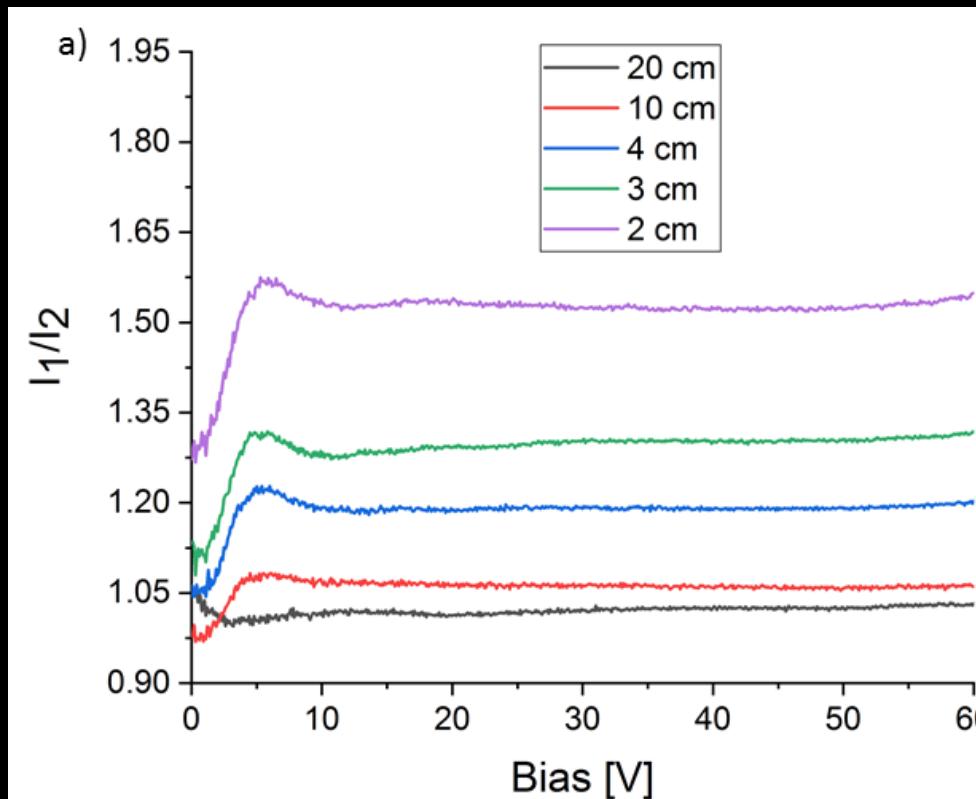
Probes in Sheath



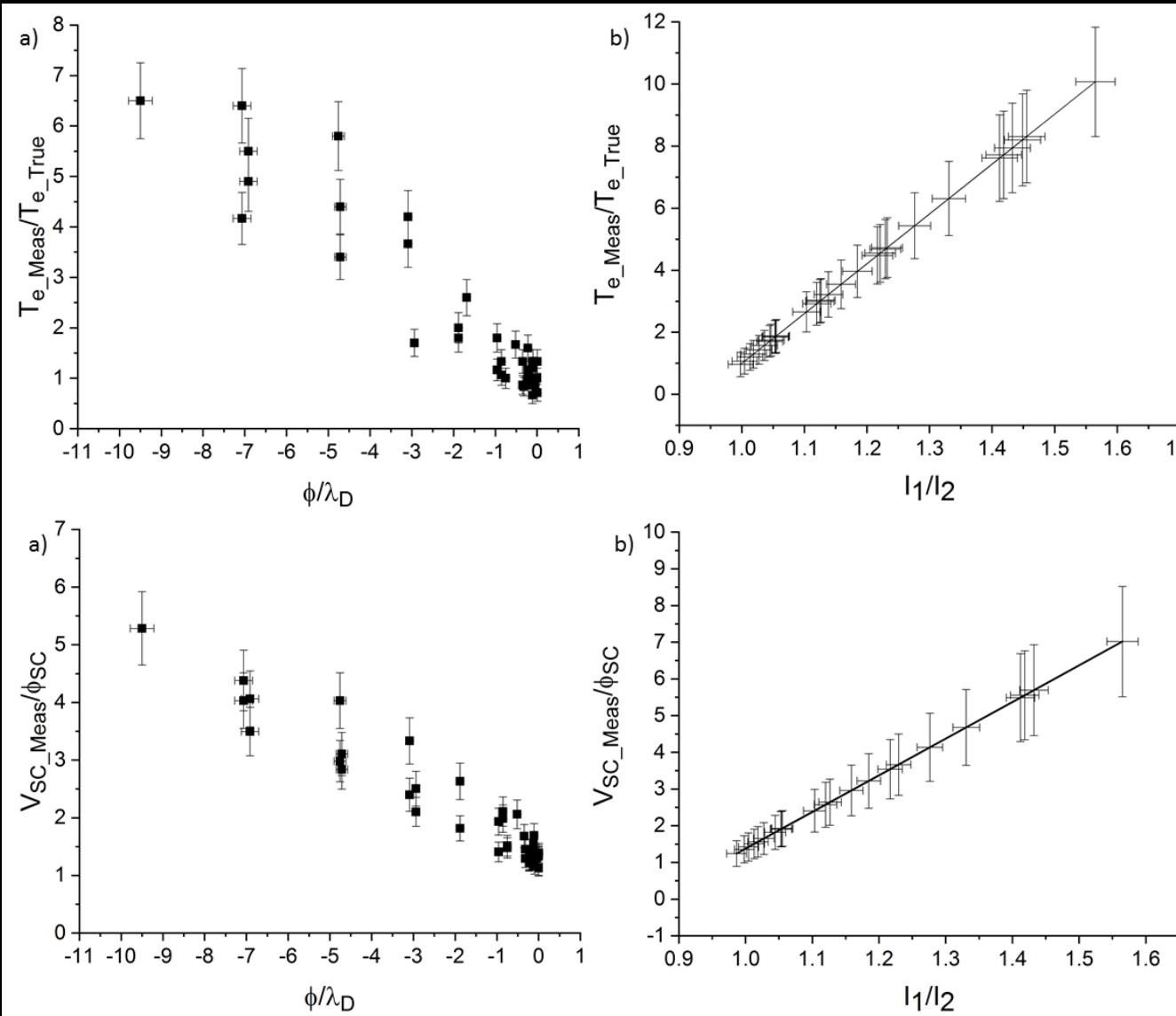
- When the probe is engulfed in the sheath of spacecraft (SC). Traditional Single Langmuir probes have issues.
- The DHP shows a difference in current collected from either hemisphere.
- The DHP uses the anisotropy in the plasma environment to its advantage.

DHP Trends in Sheath

- DHP shows clear trends in current ratio across multiple plasma conditions.
- DHP can tell how ‘deep’ you are in the sheath. $\varphi = \varphi_{bulk} - \varphi_{local}$



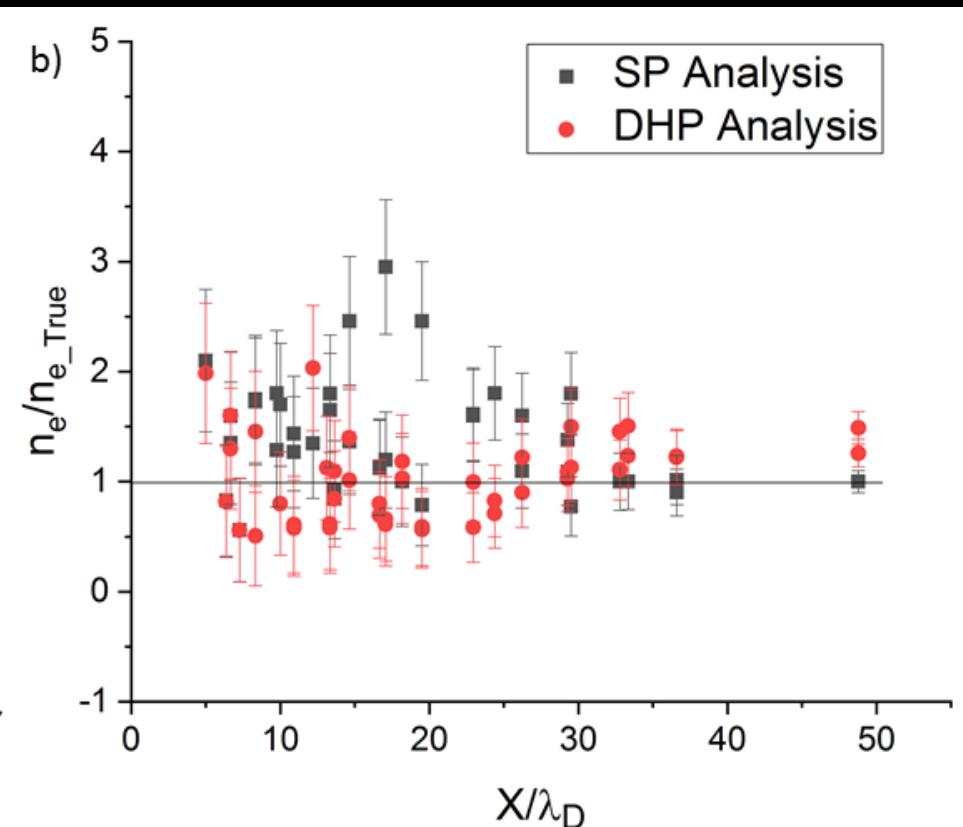
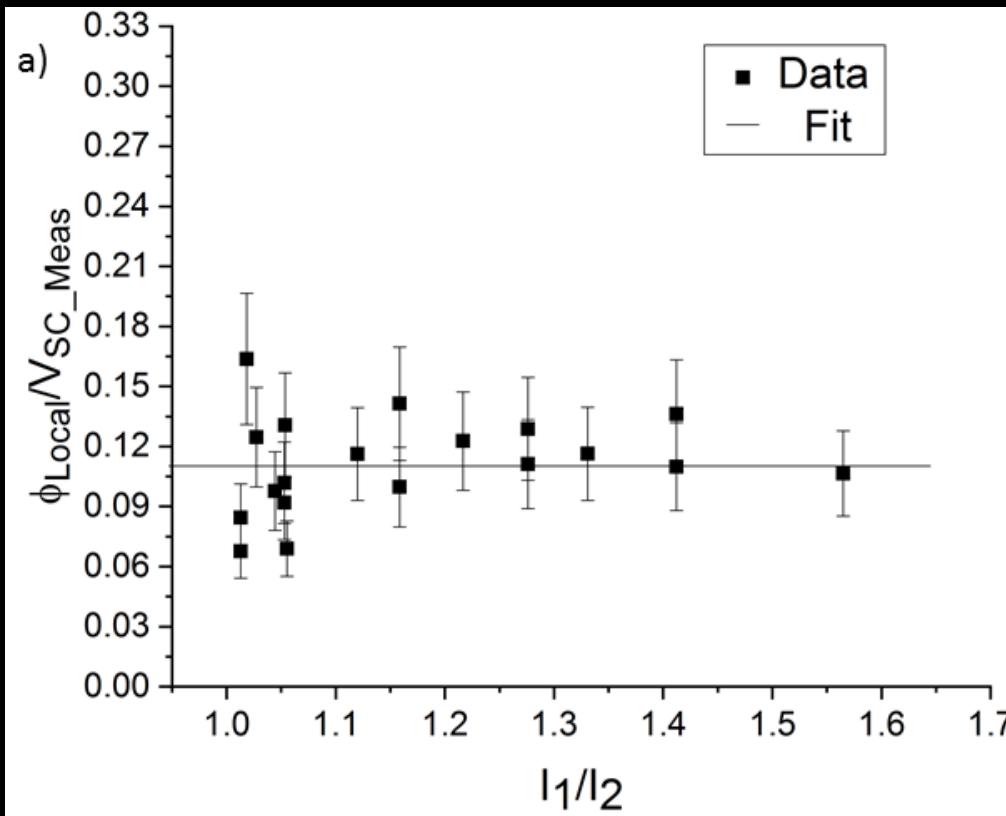
Langmuir Probes (LP)



- For SC potential and electron temperature there are clear trends with ‘sheath depth’ and ratio of measured to true plasma parameters.
- An imperial relationship can be used to calculate the expected measured to true ratio as a function of current ratio
- From there the true ambient plasma parameter can be reconstructed.

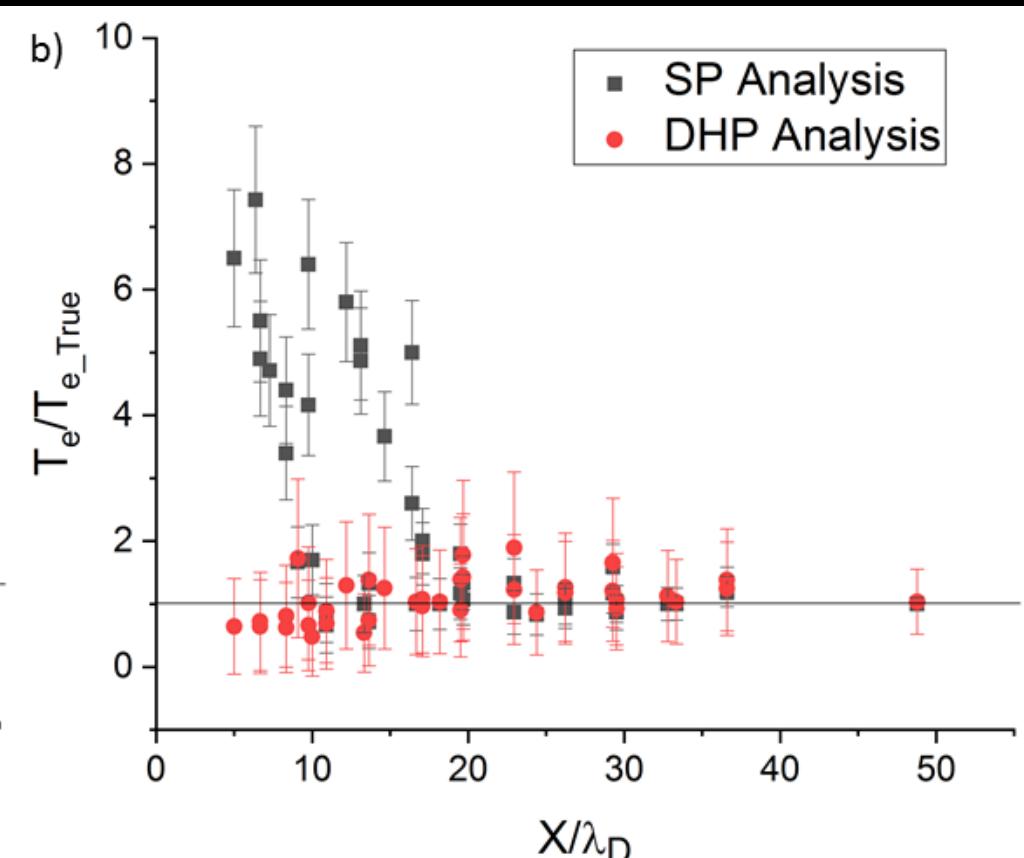
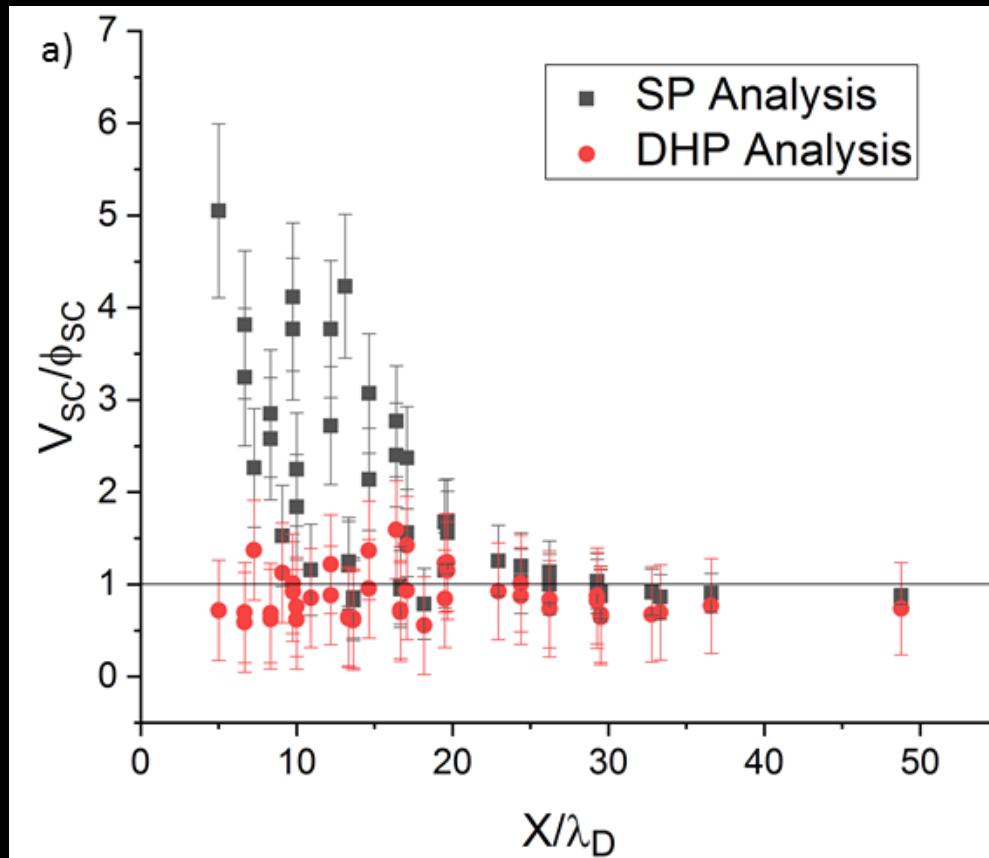
Langmuir Probes (LP)

- No clear trend was found between the measured and true electron density. Instead used the Boltzmann equation ($n_{e_Local} = n_{e_bulk} \text{Exp}(\frac{\varphi_{Local}}{T_{eTrue}})$) to reconstruct the true ambient electron density.



Langmuir Probes (LP)

- For the SC potential and the electron temperature, a clear advantage of using the DHP is shown. Limited only by ability to resolve I-V curves.



Conclusion

- The currents collected by the hemispheres of the DHP are identical in the bulk and diverge when the probe is in the sheath. The current ratio between the two hemispheres increases linearly with ‘sheath depth’ (potential gradient).
- Linear relationships established between the current ratio and the ratio of the measured to true parameter for the SC potential and electron temperature can be used for retrieving the true parameters in the ambient plasma.
- Retrieval of the electron density is done via use of the Boltzmann relation using the density measured at the probe local potential.

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Distortion of I-V curves

